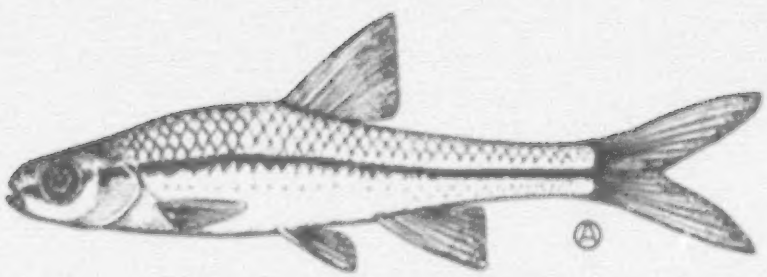
COSEWIC
Assessment and Status Report

on the

Pugnose Minnow
Opsopoeodus emiliae

in Canada



THREATENED
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Pugnose Minnow — From Scott and Crossman (1998) with permission.

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COSEWIC
Assessment Summary

Assessment Summary – May 2012

Common name
Pugnose Minnow

Scientific name
Opsopoeodus emiliae

Status
Threatened

Reason for designation
This fish is a small-bodied species with a restricted and declining distribution that inhabits river, stream and lake habitats. The species is threatened by habitat loss, habitat degradation from nutrient and sediment loading, climate change and several exotic species. The overall level of threat has been assessed as high.

Occurrence
Ontario

Status history
Designated Special Concern in April 1985. Status re-examined and confirmed in May 2000. Status re-examined and designated Threatened in May 2012.

COSEWIC
Executive Summary

Pugnose Minnow
Opsopoeodus emiliae

Wildlife Species Description and Significance

The Pugnose Minnow is a small (maximum total length is 64 mm) member of the family Cyprinidae that has a small upturned mouth, a black lateral band extending from the tail to the snout, and a criss-cross pattern of scaling particularly evident on the upper body. The dorsal fin of adult males is dusky or black with a white bar in the middle, a pattern of pigmentation that intensifies during the spawning season. Unlike any other Canadian minnow, it usually has nine principal dorsal rays. The spawning male develops patches of small tubercles on the snout, lips, and chin.

The Pugnose Minnow represents a monotypic genus. It may be useful as an indicator of aquatic ecosystem health as it prefers clear vegetated habitats that support a diverse array of taxa. Well-established northern populations at the range edge may contain unique genotypes that contribute to the overall genetic diversity and adaptability of the species.

Distribution

The Pugnose Minnow is common and widespread in the southern United States where it is found from South Carolina and Florida west to Texas. It is found in the Mississippi River system north to southeastern Wisconsin. Its Canadian distribution is limited to Ontario where it is found in the Detroit and Sydenham rivers and in Lake St. Clair and its smaller tributaries. The species is believed to be extirpated from the Thames River system.

Habitat

In the United States, the Pugnose Minnow prefers clear, slow-moving waters with abundant vegetation. In Canada, this species inhabits turbid, slow-moving or still waters with or without vegetation over boulders, woody debris, clay, silt, muck or sand substrates.

Biology

The Pugnose Minnow spawns in late May to mid-June. Spawning is believed to take place in shallow areas with submergent and emergent aquatic vegetation over substrates of silt, clay or sand. However, other sources state that males select and defend a flat surface, such as the underside of a rock, for spawning. Eggs are laid in clusters on the underside of the flat surface and are defended by the male. Nursery habitat is thought to occur in areas with abundant aquatic vegetation and substrates of silt and sand. The Pugnose Minnow feeds on a variety of small insects, crustaceans, filamentous algae and, occasionally, on larval fishes and fish eggs.

Population Sizes and Trends

The sizes of Canadian populations of the Pugnose Minnow are unknown and existing evidence is insufficient to determine trends in population numbers. In 2010, the species was not caught at many of the sites where it had been previously captured.

Threats and Limiting Factors

Factors that limit the survival of the Pugnose Minnow in Canada remain uncertain. In the United States, it is found in clear, heavily vegetated areas with little or no current. In contrast to most of its range, Ontario populations occur in turbid environments. The Pugnose Minnow Management Plan identified the overall level of concern for habitat loss and degradation, sediment loading, and nutrient loading as high, and for climate change and exotic species as medium.

Protection, Status, and Ranks

The Pugnose Minnow is listed as Special Concern under Canada's *Species at Risk Act* and the province of Ontario's *Endangered Species Act, 2007*. Several Canadian and provincial acts protect aquatic species and their habitats in general (e.g., the *Fisheries Act*). The Pugnose Minnow is considered globally secure (G5), and imperiled nationally (N2) and provincially (S2).

TECHNICAL SUMMARY

Opsopoeodus emiliae
Pugnose Minnow Petit-bec
Range of occurrence in Canada (province/territory/ocean): Ontario

Demographic Information

Generation time	1-2 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence	1254 km² (2001-10) 9303km² (All records)
Index of area of occupancy (IAO) 2 x 2 grid	84 km² (2001-10) 275 km² (All records)
Is the total population severely fragmented?	No
Number of locations* *North Sydenham River* *Sydenham River (East Branch)* *East Otter Creek* *Maxwell Creek* *Whitebread Drain* *Little Bear Creek* *MacDougall Drain (possibly extirpated)* *Chenal Ecarte* *Lake St. Clair* *Detroit River* *Thames River (extirpated)*	9 or 10
Is there an observed continuing decline in extent of occurrence? *Loss of Thames River and possibly MacDougall Drain populations and reduced extent in the North Sydenham and Detroit rivers considerably reduce extent of occurrence (approx. 87% reduction)*	Yes
Is there an observed, continuing decline in index of area of occupancy? *Loss of Thames River and possibly MacDougall Drain populations and reduced extent in the North Sydenham and Detroit rivers considerably reduce index of area of occupancy (approx. 70%).*	Yes

* See definition of location.

Is there an observed continuing decline in number of populations? *Loss of Thames River and possibly MacDougall Drain populations but new populations confirmed in Whitebread Drain since last assessment.*	No
Is there an observed continuing decline in number of locations*? *Loss of Thames River and possibly MacDougall Drain populations but new populations confirmed in Whitebread Drain and since last assessment.*	No
Is there an observed continuing decline in area, extent and/or quality of habitat?	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
All	Unknown for all
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Unknown

Threats (actual or imminent, to populations or habitats)

habitat loss and degradation, sediment loading, nutrient loading, climate change, exotic species

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? MI (END, S1); OH (END, S1)	
Is immigration known or possible?	Not known, but possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No, species is Endangered and fragmented in states adjacent to its Canadian distribution.

Current Status

COSEWIC: Special Concern (2000). Re-examined and designated Threatened (May 2012).

* See definition of location.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Threatened	B1ab(i,ii,iii)+2ab(i,ii,ii)
Reasons for designation: This fish is a small-bodied species with a restricted and declining distribution that inhabits river, stream and lake habitats. The species is threatened by habitat loss, habitat degradation from nutrient and sediment loading, climate change and several exotic species. The overall level of threat has been assessed as high.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Not applicable. No information available on the number of mature individuals.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Threatened B1ab(i,ii,iii)+2ab(i,ii,iii), as EO < 20,000 km² and IAO < 2,000 km², there are <10 locations, and evidence of continuing decline in EO, IAO, and quality of habitat.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No information available on the number of mature individuals.
Criterion D (Very Small or Restricted Total Population): Not applicable. No information available on the number of mature individuals.
Criterion E (Quantitative Analysis): Not applicable. Quantitative analysis not done.

PREFACE

The Pugnose Minnow remains an enigmatic species—nothing new has been published on its biology since the last COSEWIC report completed in 2000. However, most sites where it had been found in southwestern Ontario, and many adjacent sites, have been sampled since the last report. Although it has been captured at fewer sites, it is still present at eight of ten locations identified in the previous report, and confirmed at a new location (Whitebread Drain). As a result of its absence in the Thames River (last observed in 1968) and possible extirpation in the MacDougall Drain (last observed in 1984), extent of occurrence has declined by 87% and area of occupancy has declined by 70%. The reasons for the loss of these populations remain unclear, but it may be related to long-term degradation of habitat conditions in the river. Insufficient sampling has occurred to determine trends in abundance of any of the Canadian populations. Although threats specific to Pugnose Minnow are unknown, the main threats are believed to be degradation of habitat and water quality, and exotic species—all ongoing threats within their distribution in Canada.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Pugnose Minnow

Opsopoeodus emiliae

in Canada

2012

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Actinopterygii

Order: Cypriniformes

Family: Cyprinidae (Carps and Minnows)

Scientific name: *Opsopoeodus emiliae* Hay, 1881
Notropis emiliae (Hay), Gilbert and Bailey, 1972
Opsopoeodus emiliae Hay, Page & Johnston 1990

English Common Name: Pugnose Minnow

French Common Name: petit-bec

Originally described in 1881 in the genus *Opsopoeodus*, this species was placed in *Notropis* by Gilbert and Bailey (1972). However, osteological, chromosomal and behavioural evidence (Campos and Hubbs 1973, Dimmick 1987, Amemiya and Gold 1990, Amemiya et al. 1992, Gold et al. 1992, Johnston and Page 1992, Blanton et al. 2011) suggested that the Pugnose Minnow is distinct from *Notropis*. Eschmeyer (2010) recognized Page and Johnson (1990) as the first publication to reinstate the genus name *Opsopoeodus* for this species. While Mayden et al. (2006) suggested that *Opsopoeodus* should be embedded within *Pimephales* based on cytochrome *b* sequence data, recent work by Blanton et al. (2011) using both mitochondrial and nuclear sequences confirmed that *Opsopoeodus* should be considered a distinct genus. The *Opsopoeodus* genus is most closely related to the genera of *Pimephales* and *Codoma*. The *Pimephales* + *Codoma* + *Opsopoeodus* group is most closely related to *Cyprinella*. Gilbert and Bailey (1972) described two subspecies: *O. e. peninsularis* from the Florida peninsula, and *O. e. emiliae* occupying the rest of the range including Canada. Intergrades between the two subspecies occurred in northeast Florida and Georgia (Gilbert and Bailey 1972).

Morphological Description

The Pugnose Minnow is a small (maximum total length [TL] being 64 mm; Holm et al. 2010) member of the family Cyprinidae (Carps and Minnows) (Figure 1). It has a small upturned mouth, a black lateral band extending from the tail to the snout, and a criss-cross pattern of scaling particularly evident on the upper body (Holm et al. 2010). The dorsal fin of adult males is dusky or black with a white bar in the middle and the anterior rays of the anal fin are white, both patterns of pigmentation intensify during the spawning season (Holm et al. 2010). Unlike any other Canadian minnow, it usually has nine principal dorsal rays (Scott and Crossman 1973). There are five, ridged pharyngeal teeth in one row on each side (Scott and Crossman 1973). There may occasionally be a

fleshy barbel at the posterior end of one or both sides of the lower lip (Gilbert and Bailey 1972). The spawning male develops patches of small tubercles on the snout and chin, a pattern that has been described and figured by Gilbert and Bailey (1972).

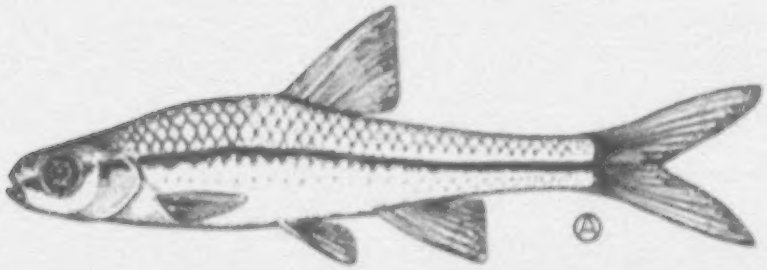

Figure 1. Pugnose Minnow, *Opsopoeodus emiliae*. From Scott and Crossman (1998) with permission.

The Pugnose Minnow can be distinguished by its nine principal dorsal rays from similar species in the family Cyprinidae, which have eight dorsal rays. It has a small, steeply upturned mouth similar to the Golden Shiner (*Notemigonus crysoleucas*) and Pugnose Shiner (*Notropis anogenus*). The Golden Shiner has a more dorso-laterally compressed body, and has a much longer anal fin with at least 12 anal rays (Holm et al. 2010). The Pugnose Minnow has a dark lateral band that extends onto the nose only; whereas the dark lateral band of the Blackchin Shiner and Pugnose Shiner extends onto the nose and chin (Holm et al. 2010). The Pugnose Shiner also lacks the criss-cross scale pattern that occurs on the Pugnose Minnow (Holm et al. 2010).

Population Spatial Structure and Variability

The degree of spatial structure of Pugnose Minnow populations in Canada is unknown.

Designatable Units

Only a single subspecies occurs in Canada (*O. e. emiliae*; Gilbert and Bailey 1972), the species occurs in a single biogeographic region (Great Lakes-Upper St. Lawrence), and the genetic population structure is unknown; therefore, only a single designatable unit occurs in Canada.

Special Significance

The Pugnose Minnow represents a monotypic genus (Nelson et al. 2004) and, as a result, the study of the unique morphology, behaviour, and genetics of this species contributes to our knowledge of the evolution of North American Cyprinidae.

Given its propensity for clear, vegetated waters in the main portion of its range (i.e., southern United States), it may be useful as an indicator of aquatic ecosystem health. Well-established northern populations at the range edge may contain unique genotypes that contribute to the overall genetic diversity and adaptability of the species.

The importance of Pugnose Minnow to First Nations people is unknown. At the time of submission, no Aboriginal Traditional Knowledge (ATK) was available for inclusion in this report (Neil Jones, COSEWIC, pers. comm.).

DISTRIBUTION

Global Range

The Pugnose Minnow is found in the eastern United States and southwestern Ontario (Figure 2). The Pugnose Minnow is more common and widespread in the southern United States where it is found from South Carolina and Florida west to Texas. It is found in the Mississippi River system northwest to southeastern Wisconsin into the Laurentian Great Lakes system and northeast to southwestern Ontario.

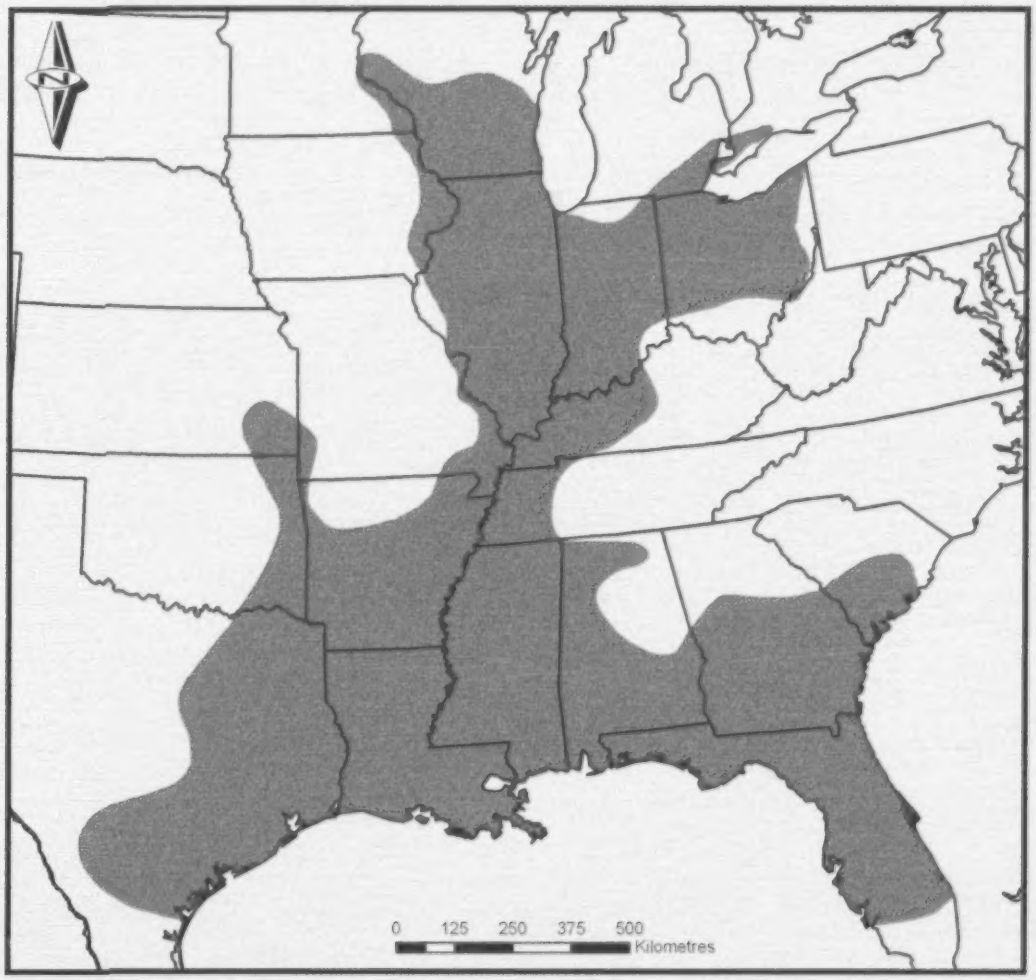

Figure 2. Global distribution of the Pugnose Minnow. Modified from Page and Burr 1991.

Canadian Range

In Canada, the Pugnose Minnow has been known historically from only 11 locations within a small area in southwestern Ontario (Figure 3), including the Detroit River, Sydenham River, Thames River, and Lake St. Clair and some of its tributaries. The Canadian range of the Pugnose Minnow represents less than 5% of the species' global range (Edwards and Staton 2009).

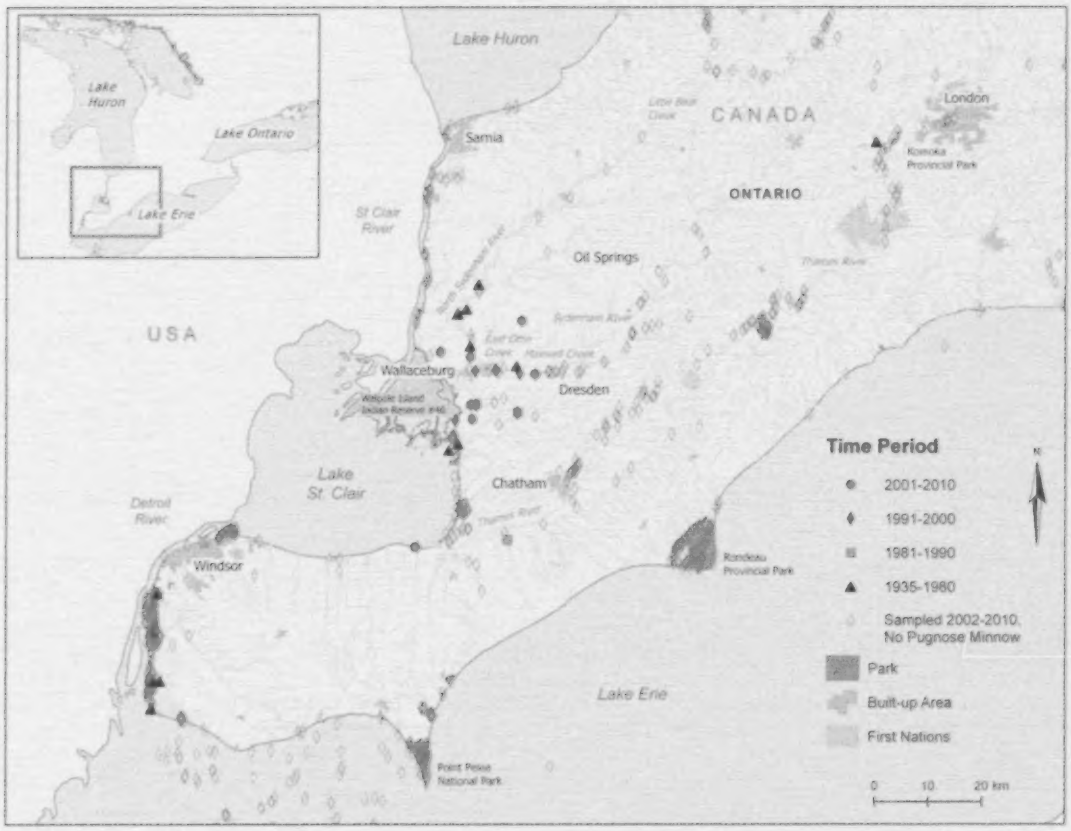

Figure 3a. The distribution of Pugnose Minnow in Canada.

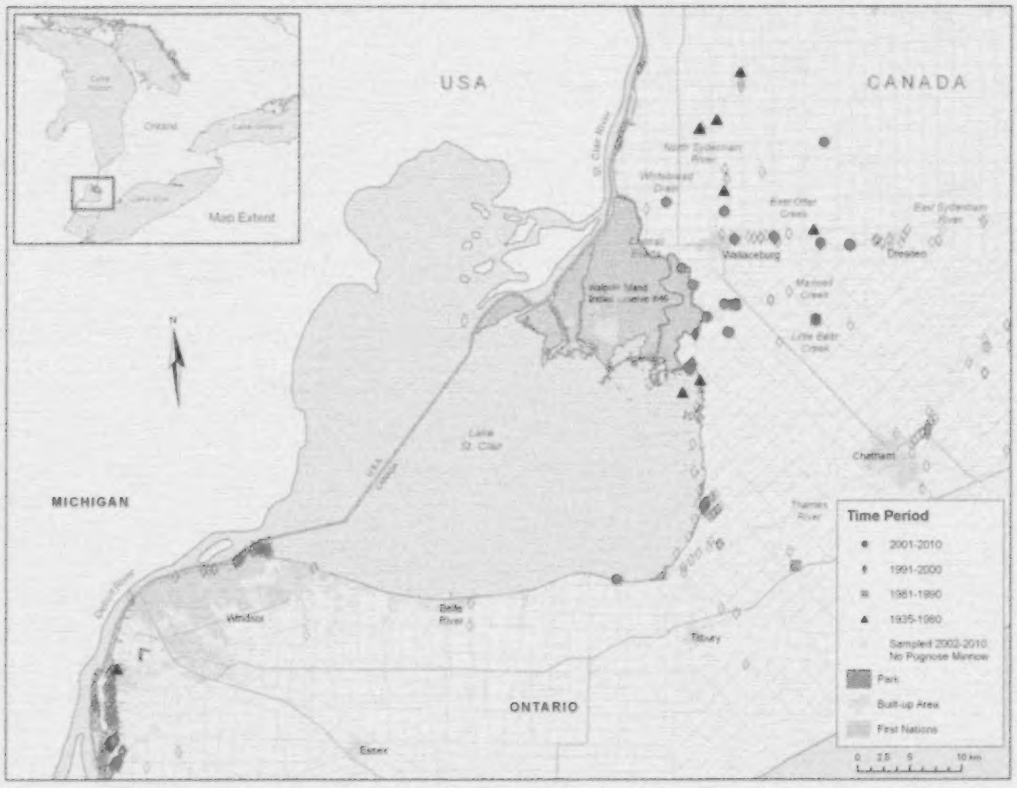

Figure 3b. Enlargement showing all sites where Pugnose Minnow have been captured between 2001-2010.

The Pugnose Minnow was first recorded in 1935 from Mitchell's Bay in Lake St. Clair (Royal Ontario Museum (ROM) Catalogue Number 8956); however, only three individuals have been confirmed from Lake St. Clair since this initial observation (two by the ROM in 1979, and a single specimen by the Ontario Ministry of Natural Resources (OMNR) in 2007) (Table 1). Four individuals were reportedly caught along the south shore in 1990 by the MNR; however, no vouchers were taken and proper identification cannot be confirmed (M. Belore, OMNR, pers. comm. 2011).

Table 1. Summary of locations and sampling history for Pugnose Minnow (PNM).

Drainage	Year Sampled	Organization	Sites Sampled	Sites with PNM	Total PNM Captured	Reference
North Sydenham R.	1979	Beak Consultants	4	4	8	Parker and McKee (1980)
	1997	ROM	2	0	0	E. Holm, unpublished data
	2003	DFO	11	1	1	Mandrak *et al.* (2006)

Drainage	Year Sampled	Organization	Sites Sampled	Sites with PNM	Total PNM Captured	Reference
	2010	DFO	6	0	0	N. Mandrak unpublished data
Sydenham R. (East Branch)	1979	Beak Consultants	1	1	1	Parker and McKee (1980)
	1997	ROM	3	3	21	Holm and Beam (1998)
	2003/2004	Poos	75	0	0	Poos (2004)
	2003	DFO	12	2	3	Mandrak et al. (2006)
	2003	DFO	27	0	0	Marson and Mandrak (2009)
	2010	Poos	10	0	0	M. Poos, DFO, pers. comm.
	2010	DFO	5	5	22	N. Mandrak, unpublished data
East Otter Cr.	1982	n/a	n/a	n/a	n/a	N. Mandrak (DFO) pers. comm.
	1996	n/a	n/a	n/a	n/a	N. Mandrak (DFO) pers. comm.
	2003	DFO	1	1	1	Mandrak et al. (2006)
	2010	DFO	1	0	0	N. Mandrak, unpublished data
Maxwell Cr.	1982	ROM	n/a	1	1	E. Holm, unpublished data
	1996	ROM	n/a	1	2	E. Holm, unpublished data
	2003	DFO	5	1	2	Mandrak et al. (2006)
	2010	DFO	2	1	1	N. Mandrak, unpublished data
Little Bear Cr.	1982	ROM	n/a	1	1	E. Holm, unpublished data
	1996	ROM	n/a	1	1	E. Holm, unpublished data
	2003	DFO	4	1	3	Mandrak et al. (2006)
	2010	DFO	4	3	15	N. Mandrak, unpublished data
Whitebread Drain	2003	DFO	2	1	18	Mandrak et al. (2006)
	2010	DFO	1	0	0	N. Mandrak, unpublished data
McDougall Drain	1984	ROM	n/a	1	2	E. Holm, unpublished data
	2004	DFO	1	0	0	Edwards and Mandrak (2006)

Drainage	Year Sampled	Organization	Sites Sampled	Sites with PNM	Total PNM Captured	Reference
	2004	UTRCA	1	0	0	J. Schwindt (UTRCA) pers. comm.
Chenal Ecarte	1993	OMNR	n/a	1	1	E. Holm, unpublished data
	2010	DFO	5	2	4	N. Mandrak, unpublished data
Lake St. Clair	1935	ROM	n/a	1	2	E. Holm, unpublished data
	1979	ROM	n/a	1	2	E. Holm, unpublished data
	1979-1981	OMNR	n/a	0	0	M. Belore (OMNR), pers. comm.
	1990-1996, 2005, 2007, 2008	OMNR	+100	1	1	M. Belore (OMNR), pers. comm.; E. Holm unpublished data
	1996	ROM	1	0	0	E. Holm (ROM), pers. comm.
	1996-2001	MDNR	extensive trawling	0	0	Thomas and Haas (2004)
	1999	ROM	87	0	0	Metzger and Holm (2000)
	2005	DFO	20	0	0	Marson et al. (2010); St. Clair National Wildlife Area
Thames River	1968	Univ. Western Ontario	1	1	7	E. Holm, unpublished data
	1996	ROM	n/a	0	0	E. Holm (ROM) pers. comm.
	2003-2004	DFO	76	0	0	Edwards and Mandrak (2006); non-wadeable sites
	2003-2004	DFO	9	0	0	Edwards and Mandrak (2006); wadeable sites
	2004	DFO	22	0	0	Edwards and Mandrak (2006); non-wadeable sites in tributaries
	2004	DFO	8	0	0	Edwards and Mandrak (2006); wadeable sites in tributaries

Drainage	Year Sampled	Organization	Sites Sampled	Sites with PNM	Total PNM Captured	Reference
	2011	OMNR	5	0	0	A. Dextrase (OMNR), unpublished data
Detroit River	1940	UMMZ	n/a	1	2	E. Holm, unpublished data
	1941	ROM	n/a	1	3	E. Holm, unpublished data
	1995	OMNR	n/a	1	56	E. Holm, unpublished data
	1996	ROM	n/a	1	2	E. Holm, unpublished data
	2003	Lapointe	30	0	0	Lapointe (2005)
	2004	Lapointe	60	1	1	Lapointe (2005)

n/a= not available; DFO = Fisheries and Oceans Canada; MDNR = Michigan Department of Natural Resources; OMNR = Ontario Ministry of Natural Resources; ROM = Royal Ontario Museum; UTRCA = Upper Thames Region Conservation Authority; UMMZ = University of Michigan Museum of Zoology.

The species was captured in 1940 in the Detroit River at Fighting Island (University of Michigan Museum of Zoology (UMMZ) Catalogue Number 130863). Parker and McKee (1980) reported it in the Detroit River based on a 1941 record (ROM 14073), although did not plot this record on their map. More recent collections by the ROM (1994-1996) and Lapointe (2005) have continued to document the presence of Pugnose Minnow in the Detroit River.

Parker and McKee (1980) also documented the species from four sites in the North Sydenham River system from Bear Creek below Brigden to the North Sydenham River above Wallaceburg (also caught in 2003 (N. Mandrak, unpublished data)), and at a single site in the Sydenham River (east branch) near Tupperville (also caught in 1997 (Holm and Boehm 1998), and 2010 (N. Mandrak, unpublished data)), and at a location in the Thames River near Delaware (despite numerous sampling efforts in this area since 1980, Pugnose Minnow have not been recaptured from the Thames River and are believed to be extirpated).

The Pugnose Minnow has been recorded from additional Lake St. Clair tributaries since 1980: the Chenal Ecarte (1993, 2010 (N. Mandrak, unpublished data)), Maxwell Creek and Little Bear Creek (1982, 1996, 2003 (Mandrak et al. 2006), 2010 (Mandrak, unpublished data)), East Otter Creek (a North Sydenham tributary, 1982, 1996, 2003 (Mandrak et al. 2006)) and MacDougall Drain, a Thames River tributary in Kent County southwest of Chatham (1984 and possibly extirpated). In 2003, the species was confirmed for the first time in Whitebread Drain (Lake St. Clair drainage) (Mandrak et al. 2006).

The species has been reportedly captured at other sites in southwestern Ontario, but cannot be verified given the lack of voucher specimens; therefore, these unverified records are excluded from further consideration. It has been reported at three additional sites in the Detroit River (1995, 1996) near Turkey Island and from a Canard River site, a Detroit River tributary, north of Amherstburg, and in western Lake Erie (J. Leslie, Fisheries and Oceans Canada (DFO), pers. comm.). Surveys carried out in 1975 and 1976 by the OMNR documented the species from four localities in the North Sydenham River northeast in Bear Creek to Petrolia. However, the vouchers were discarded and Holm and Boehm (1998) believed that these specimens were misidentified. Parker and McKee (1980) reported two records lacking voucher specimens: a record of Pugnose Minnow from Laurel Creek, a tributary of the Grand River, well outside of its known range and probably misidentified (D. Fitzgerald, University of Waterloo, pers. comm.); a record from Burnt Mill Creek, a tributary of Catfish Creek between Port Stanley and Port Burwell, resulted from a typographical error in the species code—an examination of original field collection records determined that the record was a Fathead Minnow (*Pimephales promelas*) (OMNR species code 209) not a Pugnose Minnow (species code 207). The OMNR reported the Pugnose Minnow from three sites in Lake St. Clair in 1990, but no voucher specimens are available for verification. A single specimen was reported from Long Point Bay in 2003 (EERT 2008), which would represent the most easterly location for this species; however, the voucher specimen for this record cannot be located. In about 26,000 catch records from the OMNR Long Point Bay fall index trawl data dating back to 1980, there are three records of Pugnose Minnow reported for two Inner Bay sites from same sample date in 1996; however, no vouchers were kept, and the identification is doubtful (L. Witzel, OMNR, pers. comm.).

The Pugnose Minnow is now believed to be extant at 9 or 10 locations, possibly extirpated in MacDougall Drain (last observed in 1984), and extirpated within the Thames River (last observed in 1968). The current extent of occurrence for Pugnose Minnow is estimated to be 1254 km^2 and represents collections completed in 2001-2010. Given the believed extirpation of the species from the Thames River system, this represents a decrease in the extent of occurrence of nearly 87% over the historical distribution in Canada (9303km^2). Similarly, the estimated current index of area of occupancy is 84km^2, compared to 275km^2 when considering all historical records—a decrease of nearly 70%.

HABITAT

Habitat Requirements

Relatively little is known regarding the habitat requirements of Canadian populations of Pugnose Minnow. It has been stated that Pugnose Minnow prefer clear, slow-moving waters with abundant vegetation (Scott and Crossman 1973, Trautman 1981, Coad 1995). Parker et al. (1987) collected this species from turbid environments. In 1996 and 1997, the ROM collected Pugnose Minnow from habitats similar to those described by Parker et al. (1987)—Secchi depth was 0.1-0.3 m and bottom composition

was silt, muck and detritus with some cover of boulders, woody debris and aquatic vegetation (E. Holm, unpublished data). The Chenal Ecarte and Detroit River records were caught in clear, slow-moving side channels with abundant vegetation (N. Mandrak, unpublished data).

Pugnose Minnow were caught at seven sites by DFO in 2003 and were generally found at sites with abundant vegetation, silt and clay substrates, high turbidity with Secchi depths ranging from 0.07 to 0.59 m, with summer water temperatures of 18-25°C (Mandrak et al. 2006). In 2010, DFO caught Pugnose Minnow at eleven sites, with habitat being comprised of either submergent vegetation or open water, silt and sand substrates and summer water temperatures ranging from 22-30°C (N. Mandrak, unpublished data).

Therefore, in Canada, this species currently inhabits primarily turbid, slow-moving waters with abundant vegetation over silt, sand and clay substrates.

Habitat Trends

Pugnose Minnow inhabit shallow, slow-moving habitats, often associated with riparian wetlands and nearshore areas. Consequently, ongoing riparian development and draining and/or filling of wetland habitats are likely contributing to the overall loss of suitable habitat; however, it is unclear the degree to which such losses are occurring. Within the Canadian range of this species, much of the habitat degradation has occurred in the past and, although it still persists today, ongoing degradation is likely less pervasive than historically.

BIOLOGY

Except for brief generalizations by Parker et al. (1987), very little has been written concerning the biology of the Pugnose Minnow in Canada. Most of the data related to biology and ecology of Pugnose Minnow are from American sources, and is the basis for much of the documented information provided in this section.

Life Cycle and Reproduction

In Canada, adults are generally 35-58 mm in total length (TL), not exceeding 64 mm (Parker et al. 1987; Holm et al. 2010). The age or size range at which this species attains sexual maturity is unknown, but is likely 1 year of age, as is typical with most small cyprinids.

Although evidence suggests that the Pugnose Minnow has a protracted breeding season in Florida, this does not seem to be true for other North American populations (Gilbert and Bailey 1972). Breeding individuals in Arkansas were observed in late May, while gravid females were found in Illinois in mid-June (Gilbert and Bailey 1972). Pugnose Minnow in Missouri were found in spawning condition in early summer

(Pflieger 1975). Based upon timing of spawning in populations in the northern United States, it is likely that spawning in Canada occurs in spring, late May to mid-June (Holm et al. 2010). One female (ROM 35781), collected in Mitchell's Bay, had not yet spawned on 2 June 1979 when the water temperature was 21°C. Spawning is believed to take place at depths of 0- 2m in areas with submergent and emergent aquatic vegetation over substrates of silt, clay or sand (Lane et al. 1996a). Similar habitats are thought to provide nursery habitat for the Pugnose Minnow (Lane et al. 1996b).

The egg clustering and parental care behaviour of the Pugnose Minnow is a complex breeding strategy and, along with that of species of *Pimephales* and *Codoma*, is unique among North American cyprinids. The following account is based primarily on Page and Johnston (1990) and Johnston and Page (1992).

Breeding males develop a dark silver-blue body and white tips on the anal and pelvic fins. Patches of tubercles develop on the male's chin and snout (Gilbert and Bailey 1972). Small white knobs develop on the first three dorsal fin rays and may act as egg mimics to stimulate the female to spawn. Males select a flat surface, such as the underside of a rock, as their spawning site. Based on laboratory observations, the Pugnose Minnow defends its territory from intruders by chasing them from the immediate vicinity of the spawning site. The male exhibits figure "8" circling behaviour at the spawning site and rubs his snout or nape on the surface. The rapid raising and lowering of the male dorsal fin may be used to signal the female to attract her to the nest. Females are led to the spawning site by the males, where the female repeatedly touches the surface of the spawning site with her mouth and snout. The male follows the female, nudging and lifting her abdomen and caudal peduncle with his snout.

The spawning act consists of the pair aligning laterally and inverting for about a second. This act is repeated several times. For the female to deposit the eggs, she inverts so the genital papilla is able to come into contact with the spawning surface. Eggs are laid singly or in strings of 2-5 forming a single layer on the underside of the flat surface. Up to 120 eggs are laid per spawning session. This is repeated over 6-7 days. The average diameter of the eggs is 1.3 mm. Males defend the nests and eggs from potential predators, and the single layer of eggs allows the male access to the individual eggs. In the laboratory study, eggs hatched in a mean of 142 hours (S.D. = 8.9) at 21°C. Newly hatched larvae are 5.0-5.5 mm TL long (Page and Johnston 1990).

The Pugnose Minnow's upturned mouth suggests it is adapted to feeding on small prey items located within the water column or on the surface of the water. In Ontario, one specimen had adult Diptera and larval Trichoptera in the stomach (Parker et al. 1987). Gut contents of Florida specimens consisted of chironomid larvae, filamentous algae, small crustaceans, larval fish, and fish eggs (Parker et al. 1987). No studies were found on the diet of the Pugnose Minnow since those reported by Parker et al. (1987). Its small mouth likely limits the size of plant and animal organisms taken.

The lifespan of the Pugnose Minnow is approximately 3 years (Parker et al. 1987). Generation time is unknown but, like other cyprinids, is probably around 1 year. Potential for hybridization is unknown. Population size structure and sex ratios are unknown.

Physiology and Adaptability

Very little is known regarding the physiology and tolerances of the Pugnose Minnow. Accounts by Scott and Crossman (1973) and Trautman (1981) suggested that the species is sensitive to high levels of turbidity; however, recent sampling efforts have demonstrated that the species is found in turbid habitats. It is unclear if their presence in turbid habitats in Canada suggests some tolerance to these conditions or that populations are hanging on in sub-optimal habitats. The method of depositing eggs on the underside of flat objects likely provides some protection to the eggs and emergent fry from siltation (Waters 1995).

Dispersal and Migration

It is not known if Pugnose Minnow undergoes some degree of migration during spawning or overwintering. Given their small size, it is unlikely that Pugnose Minnow migrate or disperse over long distances.

Interspecific Interactions

Pugnose Minnow is likely preyed upon by a variety of fishes. Given its low abundance and occurrence in turbid habitats, it is unlikely that it is a main prey item for piscine or avian predators. In southwestern Ontario, Pugnose Minnow are often collected at the same sites as Blackstripe Topminnow (Mandrak et al. 2006).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

In 2010, DFO conducted targeted sampling of most historic sites of Pugnose Minnow using fine mesh seine nets and a minimum of three seine hauls (Table 1). Where the species was detected, a minimum of five seine hauls were undertaken to estimate population sizes using a depletion method. Unfortunately, the species was not collected in sufficient numbers to estimate population size at any location where it was captured (N. Mandrak, unpublished data). In addition, between 2002 and 2009, DFO conducted many surveys within the range of the Pugnose Minnow in southwestern Ontario using a variety of effort and gears (fine-mesh seines, boat seines, backpack electrofisher, boat electrofisher, fine-mesh trawls, fine-mesh fyke nets, minnow traps, Windermere traps) (Figure 3) (Mandrak et al. 2006, Marson and Mandrak 2009, Marson et al. 2010; N. Mandrak, unpublished data).

A total of only eight specimens were captured at four sites in the North Sydenham River system in 1979 (Parker and McKee 1980). Attempts to sample some North Sydenham River sites in 1996 by the ROM were hindered by high water levels. In 1997, two of four sites in the North Sydenham River where the species was previously found were sampled and no specimens were captured (E. Holm, unpublished data). In 2003, DFO sampled 11 wadeable sites on the North Sydenham River and captured a single Pugnose Minnow (Mandrak et al. 2006) but failed to capture any specimens at six sites seined in 2010 (N. Mandrak, unpublished data).

In 1997, the ROM captured 21 specimens of Pugnose Minnow in seines at three sites in the Sydenham River (East Branch); it was captured at Tupperville where it was collected in 1979 and at two new sites between Wallaceburg and Tupperville (E. Holm, unpublished data). In 2003 and 2004, Poos (2004) intensively sampled 75 wadeable sites throughout the Sydenham River drainage (including North and East branches and Black and Bear Creeks) using a backpack electrofisher, seines, minnow traps, and Windermere traps and did not collect any Pugnose Minnow. In 2003, DFO sampled 27 non-wadeable sites on the lower portion of the Sydenham River using gear including boat electrofisher, boat seines, fine-mesh fyke nets, and minnow traps (Marson and Mandrak 2009). No Pugnose Minnow were collected. In the same year, DFO caught Pugnose Minnow (three individuals) at two of 12 wadeable sites on the Sydenham River using backpack electrofishing and seining (Mandrak et al. 2006). During the same sampling, no Pugnose Minnow were collected at five sites in Fansher Creek, a tributary to the Sydenham River (Mandrak et al. 2006). In 2010, a total of 22 Pugnose Minnow were caught at five sites seined in the lower portion of the Sydenham River (N. Mandrak, unpublished data). In the same year, 10 sites were sampled above Dawn Mills on the Sydenham River (East Branch) using backpack electrofisher and seines, and no Pugnose Minnow were captured (M. Poos, DFO, pers. comm.).

Pugnose Minnow were initially captured in the Chenal Ecarte (a human-made channel that runs between St. Clair River and Lake St. Clair) by the ROM in 1993. DFO sampled five sites in the Chenal Ecarte in 2010 and captured four specimens from two sites (Mandrak, unpublished data).

In 2003 and 2010, DFO sampled several tributaries to Lake St. Clair where historical sampling (i.e., 1982, 1996) yielded Pugnose Minnow. In 2003, a single Pugnose Minnow was caught by seining in East Otter Creek at the only site sampled (Mandrak et al. 2006); none were caught at one site seined in 2010 (N. Mandrak, unpublished data). In 2003, a single site sampled in West Otter Creek yielded Blackstripe Topminnow, but no Pugnose Minnow (Mandrak et al. 2006).
In 2003, two Pugnose Minnow were caught by seining in Maxwell Creek at one of five sites sampled (Mandrak et al. 2006). In 2010, DFO caught a single Pugnose Minnow at one of two sites seined in Maxwell Creek (N. Mandrak, unpublished data). In 2003, three Pugnose Minnow were collected at one of four sites sampled on Little Bear Creek using seines (Mandrak et al. 2006). In 2010, DFO caught a total of 15 Pugnose Minnow at three of four sites seined in Little Bear Creek (N. Mandrak, unpublished data). In 2003, 18 Pugnose Minnow were collected using seines in one of two sites sampled in

Whitebread Drain (Mandrak et al. 2006), a drainage system that was not previously known to contain Pugnose Minnow; however, none were caught at a single site seined in 2010 (N. Mandrak, unpublished data).

Specimens have not been recorded from the Thames River system since the initial capture of seven specimens in 1968 near Delaware (ROM 26480). Sampling attempts made by the ROM in 1996 in the general vicinity of this record failed to capture any Pugnose Minnow; however, the imprecise locality description of the 1968 collection made it impossible to locate the site precisely (E. Holm, ROM, pers. comm.). During this sampling, the ROM sampled suitable habitat in Oxbow Creek (a Thames River tributary, near Komoka and the general vicinity of the initial record) but no Pugnose Minnow were captured (E. Holm, ROM, pers. comm.). In July 2011, S. Gibson and A. Dextrase (OMNR) targeted five sites upstream of Delaware having submerged vegetation (which is relatively rare in the Thames River between Delaware and London) but no Pugnose Minnow were observed (A. Dextrase, unpublished data). In 2003 and 2004, DFO sampled 76 non-wadeable and nine wadeable sites in the lower Thames River using multiple gears and did not collect any Pugnose Minnow (Edwards and Mandrak 2006). In 2004, DFO sampled 22 non-wadeable and eight wadeable sites in tributaries to the lower Thames River using multiple gears and did not collect any Pugnose Minnow (Edwards and Mandrak 2006). Part of DFO's 2004 sampling of Thames River tributaries targeted MacDougall Drain, which historically (i.e., 1984) contained Pugnose Minnow; however, no specimens were observed at the only site sampled. In addition, the Upper Thames Region Conservation Authority (UTRCA) sampled a single site in the fall of 2004 and did not capture any specimens (J. Schwindt, UTRCA, pers. comm.).

Pugnose Minnow were first recorded from Lake St. Clair in 1935 based on specimens collected in Mitchell's Bay. The ROM captured two specimens from Mitchell's Bay in 1979; however, sampling at the same site by the ROM in 1996 failed to detect any additional specimens. During May to September 1999, a comprehensive sampling program was carried out on coastal wetlands on Walpole Island, which appeared to have optimal habitat conditions for the species (i.e., extensive areas of clear vegetated habitats) (Metsger and Holm 2000). The Pugnose Minnow was not captured at any of the 87 sites sampled. In 2005, DFO sampled 20 sites in the St. Clair National Wildlife Area using fine-mesh fyke nets and did not collect any Pugnose Minnow (Marson et al. 2010). The OMNR conducted nearshore surveys in Mitchell's Bay in 1979-1981 and at more than 100 sites across all of Lake St. Clair in 1990-1996, 2005, and 2007-2010 using seines (and boat electrofishing in 2007) and caught a single Pugnose Minnow in 2007 (M. Belore, OMNR, pers. comm.). No specimens were collected in Lake St. Clair itself, including Canadian waters, during extensive trawling conducted by the Michigan Department of Natural Resources between 1996 and 2001 (Thomas and Haas 2004).

In 1940-1941, sampling on the Canadian side of the Detroit River by the ROM resulted in the capture of five specimens. More recent ROM sampling in the upper Detroit River in 1994-1996 has resulted in the capture of considerably more individuals (138 specimens). However, this is not necessarily evidence of an increase in population

level as the later surveys included considerably more sites, involved greater sampling effort, and used a variety of gear types that improved capture efficiency. Lapointe (2005) intensively sampled shallow water sites throughout the Detroit River using seine nets, boat electrofishing, hoop nets, Windermere traps, trap nets, and minnow traps in 2003 (30 sites), and strictly seine nets in 2004 (60 sites) and collected a single specimen of Pugnose Minnow near Turkey Island in 2004.

Abundance

Given its infrequent presence on the landscape and the relatively low number of individuals that have been captured at a site, no abundance estimates are available for Pugnose Minnow populations in Canada. Its infrequent occurrence in collections suggests that numbers are relatively low.

Fluctuations and Trends

As a result of the likely extirpation from the Thames River population, the distribution of Pugnose Minnow appears to have decreased considerably in Ontario (Figure 3). The species rarely occurs in high numbers, making it difficult to detect appreciable fluctuations in abundance over time. Given the difficulty in standardizing catch-per-unit-effort among gear types, the relatively few individuals captured and the lack of abundance estimates available for Pugnose Minnow populations in Canada, trends in abundance remain unknown.

It may be reasonable to suspect declines in the Detroit River populations given that sampling efforts by the OMNR in 1995 observed the highest numbers of Pugnose Minnow ever recorded in Canada (i.e., 56) yet sampling of 90 sites in 2003-2004 by Lapointe (2005) found only a single individual.

Rescue Effect

The probability of local extirpation may be reduced as suitable habitat may exist throughout the Detroit River and Lake St. Clair systems, potentially allowing movement among Canadian populations and into Canada from U.S. populations. But as the species has a fragmented distribution and is critically imperiled (S1) in the states adjacent to Canada (Ohio and Michigan) there is likely limited potential for rescue from these populations. In addition, U.S. populations occur in Western Lake Erie tributaries located downstream of the Detroit River, where river flows and depths of Lake Erie may act as habitat barriers limiting dispersal of individuals into Canada.

THREATS AND LIMITING FACTORS

Factors that limit the survival and health of Pugnose Minnow populations are unknown. The Pugnose Minnow has been described as avoiding highly turbid or silted waters (Gilbert and Bailey 1972, Scott and Crossman 1973). Pflieger (1975) and Smith (1979) stated that the largest populations of Pugnose Minnow in Missouri and Illinois were found in clear, heavily vegetated areas with little or no current. However, the turbid environments from which this species was collected in Ontario suggest some ability to survive under high turbidity levels or that populations are hanging on in marginal habitat conditions. The extent of this turbidity tolerance is unknown, but Trautman (1981) and Parker et al. (1987) suggested that turbid environments provide marginal habitat. Turbid water would likely reduce the effectiveness of the males mating display. Therefore, it is likely that the abundance of the Pugnose Minnow is still limited by siltation and turbidity.

The Pugnose Minnow Management Plan identified the overall level of concern for habitat loss and degradation, sediment loading, and nutrient loading as high, and for climate change and exotic species as medium (Edwards and Staton 2009) (Table 2). The following threat descriptions have been taken from the Pugnose Minnow Management Plan (Edwards and Staton 2009).

Table 2. Threat classification table for the Pugnose Minnow in Canada (adapted from Edwards and Staton 2009).

Specific Threat	Extent (widespread/ localized)	Frequency (seasonal/ continuous)	Causal Certainty (high, medium, low)	Severity (high, medium, low)	Overall Level of Concern (high, medium, low)
Habitat Degradation	Widespread	Continuous	High	High	High
Nutrient Loading	Widespread	Seasonal	High	High	High
Sediment Loading	Widespread	Continuous	High	High	High
Climate Change	Widespread	Continuous	Low	Medium	Medium
Exotic Species	Widespread	Continuous	Low	High	Medium
Altered Coastal Processes	Widespread	Continuous	Unknown	Unknown	Unknown
Incidental Harvest	Unknown	Unknown	Unknown	Unknown	Unknown
Barriers to Movement	Unknown	Unknown	Unknown	Unknown	Unknown

Habitat Loss and Degradation

The loss of wetland and riparian forest habitats across southern Ontario has been dramatic since the late 1800s. Continued development of wetlands is a concern, primarily for those wetlands without protection from development pressures. Habitat loss in the form of lake and river shoreline modifications (e.g., shoreline stabilization projects, docks, marinas) along Lake St. Clair and the Detroit River are also a significant and ongoing concern. Modification of inland watercourses through subsurface and surface drainage activities has also negatively affected hydrological networks, and reduced the extent and quality of aquatic habitat. Livestock access to watercourses in both the Sydenham and Thames watersheds has resulted in the destruction of

important riparian habitats that provide cover and a source of food for many fish species, including Pugnose Minnow. Riparian strips have also been destroyed in recreational or urban areas, more so in the Thames River watershed, where the grass is often mowed to the edge of the waterway (TRRT 2005).

Sediment Loading

Sediment loading affects aquatic habitats through decreasing water clarity, increasing siltation of substrates, and may have a role in the selective transport of pollutants, including phosphorus. Increasing turbidity, as a result of sediment loading, can reduce the amount of aquatic vegetation present, as sunlight cannot penetrate deep into the water. This can have detrimental impacts on species that rely on dense growths of submerged macrophytes, including Pugnose Minnow. Sediment loading, and resulting turbidity and siltation, can impact species by affecting their respiration, vision and prey abundance, and smothering eggs deposited on the substrate. While many Pugnose Minnow populations in Canada have been found in turbid habitats, it is unclear if the species is able to tolerate moderate amounts of turbidity and siltation or if populations have been reduced to low numbers and are simply hanging on in sub-optimal conditions.

Nutrient Loading

Nutrients (nitrates and phosphates) enter waterbodies through a variety of pathways, including manure and fertilizer applications to farmland, manure spills, sewage treatment plants, and faulty domestic septic systems. Nutrient enrichment of waterways can negatively influence aquatic health through algal blooms and associated reduced dissolved oxygen concentrations. Elevated nutrient concentrations may be contributing to the decline of Pugnose Minnow, to reductions in their distribution, or to limiting them from expanding their distribution. The persistent, elevated concentrations of total phosphorus and nitrate ion concentrations in waterbodies such as the Sydenham and Thames rivers suggest that this is an ongoing problem (UTRCA 2007, SCRCA 2008).

Exotic Species

Exotic species may affect the Pugnose Minnow through direct competition for space and habitat, competition for food, and restructuring of aquatic food webs. There are now at least 182 exotic species that have invaded the Great Lakes basin since 1840 (Ricciardi 2006), and at least some of these species will affect populations of Pugnose Minnow to some extent. Dextrase and Mandrak (2006) indicated that, while habitat loss and degradation is the predominant threat affecting aquatic species at risk, exotic species are the second most prevalent threat, affecting 26 of 41 federally listed species across Canada. The Common Carp (*Cyprinus carpio*), Round Goby (*Neogobius melanostomus*) and Zebra Mussel (*Dreissena polymorpha*) are three exotic species that have had a dramatic effect on many aquatic species at risk, and will continue to alter ecosystems and ecosystem processes. Exotic species are also a concern for coastal

wetlands in that they can significantly change marsh vegetation communities. Two species of particular concern include Common Reed Grass (*Phragmites australis*) and Purple Loosestrife (*Lythrum salicaria*).

Altered Coastal Processes

Natural coastal processes that occur near the shorelines, along lakes and large rivers, include sediment erosion and deposition that provide and maintain habitat for fishes. Much of the shoreline habitat along Lake St. Clair and the Detroit River has been artificially hardened, filled, dredged and modified for human use. In addition, the Detroit River itself has been significantly altered through the creation of shipping lanes, which resulted in the deepening of the channel, the creation of artificially hardened shoreline walls, and the modification of flow patterns in the river. As a result, the natural processes of erosion and deposition along the St. Clair River-Detroit River corridor have been altered. The Pugnose Minnow could be negatively impacted by these alterations. Little is known about the impacts of shoreline alteration on natural coastal processes in the Great Lakes basin; therefore, additional research is required to clarify this threat.

Climate Change

Climate change is expected to have significant effects on aquatic communities of the Great Lakes basin through several mechanisms, including increases in water and air temperatures; lowering of water levels; shortening of the duration of ice cover; increases in the frequency of extreme weather events; emergence of diseases; and shifts in predator-prey dynamics (Lemmen and Warren 2004). Additionally, warming trends, as a result of climate change, may favour the establishment of potentially harmful exotic species that may currently be limited by cooler water temperatures. It is anticipated that the effects of climate change will be widespread and should be considered a contributing impact to species at risk and all habitats. In a recent assessment of the projected impacts of climate change on coastal wetland fish assemblages in the Lower Great Lakes, Doka et al. (2006) predicted that several currently at-risk species would be the most vulnerable. They considered Pugnose Minnow the most vulnerable out of the 99 fish species assessed. Vulnerabilities were based on an assessment of climate change risk associated with coastal wetland and thermal preferences for different life stages as well as species' distributions.

Incidental Harvest

Fishery activities that indirectly impact species at risk can have a negative effect on their populations. Of primary concern to Pugnose Minnow is the incidental by-catch of fishes in commercial baitfish operations. Baitfish harvesting is regulated in Ontario and a list of legal baitfish is updated based on the current list of Schedule 1 species at risk (Cudmore and Mandrak 2010). The Pugnose Minnow is not a legal baitfish in Ontario (OMNR 2010); however, it is taken incidentally.

Barriers to Movement

Three types of barriers to fish movement are found in southwestern Ontario: 1) dams and weirs; 2) pumped watercourses; and, 3) dyked wetlands. Several watercourses that drain into Lake St. Clair have pumps to ensure proper drainage of inland tributaries and drains. It is not clear to what degree these pumps restrict access to fishes in these watercourses. Site-specific conditions may afford protection for some species from competitors, exotic species and predators; however, the barriers may prevent access to suitable habitat and lead to fragmentation of populations.

PROTECTION, STATUS, AND RANKS

The Pugnose Minnow is listed as Special Concern under the federal *Species at Risk Act* (SARA) and has been protected under the SARA as of June 2004. Additional protection is given through the federal *Fisheries Act*. A management plan has been developed for the Pugnose Minnow through the SARA (Edwards and Staton 2009). It is also addressed in the Sydenham River Species-at-Risk Recovery Strategy (Dextrase et al. 2003), Thames River Aquatic Ecosystem Recovery Strategy (TRRT 2005), and Essex-Erie Region Fishes at Risk Recovery Strategy (EERT 2008). Additionally, Endangered and Threatened species that occur within the range of the Pugnose Minnow and that have single-species recovery strategies include: the Spotted Gar (*Lepisosteus oculatus*), Lake Chubsucker (*Erimyzon sucetta*), Pugnose Shiner, and Northern Madtom (*Noturus stigmosus*). These recovery plans may be relevant to the management of the Pugnose Minnow (Edwards and Staton 2009).

In Ontario, the Pugnose Minnow is listed as Special Concern but the species and its habitat are not protected under the *Endangered Species Act,* 2007. Destruction or alteration of riparian areas and wetlands are regulated and protected under the *Conservation Authorities Act* and under the Provincial *Planning Act*.

Non-Legal Status and Ranks

According to NatureServe (2011), the Pugnose Minnow is considered to be 'Secure' both globally (G5) and within the United States (N5); however, it is considered to be 'Imperiled' (N2) nationally in Canada (Table 3). The American Fisheries Society does not consider Pugnose Minnow as an imperiled species (Jelks et al. 2008) in North America. Pugnose Minnow is considered to be 'Secure' (S5) or 'Apparently Secure' (S4) in 8 of the 21 jurisdictions in which it is found, and 'Vulnerable – Apparently Secure' (S3, S3S4) in an additional six jurisdictions (Table 3). The species is considered 'Imperiled' (S2) in Ontario, 'Critically Imperiled' (S1) in Michigan, Ohio, and Pennsylvania, and Extirpated (SX) in West Virginia (NatureServe 2011).

Table 3. Global, National and Subnational heritage ranks for Pugnose Minnow (*Opsopoeodus emiliae*) (NatureServe 2011).

Rank Level	Rank	Jurisdictions
Global	G5	------
National	N5	United States
	S2	Canada
Subnational	S5	Alabama, Louisiana, Mississippi, Tennessee
	S4S5	Kentucky
	S4	Minnesota, Missouri, Texas
	S3S4	Arkansas
	S3	Georgia, Iowa, Indiana, Oklahoma, Wisconsin
	S2S3	Illinois
	S2	Ontario
	S1	Michigan, Ohio, Pennsylvania
	SNR	Florida
	SX	West Virginia

Habitat Protection and Ownership

In Canada, the habitat of Pugnose Minnow and all fishes is protected under the federal *Fisheries Act*, which prohibits harmful alteration, disruption or destruction of fish habitat. Most of the lands adjacent to known sites of Pugnose Minnow are private. In Ontario, few, if any, parks and conservation areas have been established specifically to preserve aquatic biodiversity. However, some actually do protect aquatic biodiversity as a result of their location and management practices (Mandrak and Brodribb 2005). Komoka Provincial Park may serve to protect the Pugnose Minnow, if still present in the Thames River watershed.

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None.